

MANUFACTURING ENGINEERING LABORATORY'S

WELD ENVIRONMENTAL CONTROL

A Presentation By

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The Manufacturing Engineering Laboratory of The Marshall Space Flight Center is, at present, developing environmental controlled areas for the fabrication of the S-IC Vehicle. The purpose of environmental control is to insure that all of the welds made in space vehicle structures will be of a high and reproducible quality. The first slide (Figure 1) illustrates the X-ray quality that is often found in aluminum welds made in the horizontal position. In fact, this is typical of the porosity that was seen in one of the earlier welds joining the Y-ring to the bulkhead in the S-IC Vehicle. This slide shows both excessive linear and large size porosity in the weld area which is most unacceptable and would result in lower properties and possible leaks in tank structures. The aim of environment control is to overcome this difficulty.

Here at Marshall Space Flight Center we have installed a semiportable atmospheric control system for two areas in the weld fabrication of the S-IC Vehicle. The first area (Figure 2) is shown in the next slide. This is for the weld fabrication of the bulkheads. Both the "Meridian" welds and the "Y-ring-to-Bulkhead" welds are made at this station. The method for controlling the atmosphere at this station was to install large massive plastic draw curtains around the weld fixture. This effectively seals off this area from the rest of the building. A 10 ton air-conditioning unit is used to reduce the dust level and to control the temperature and humidity for welding. An additional feature is the fact that this sealing-off of the area keeps unwanted personnel from visiting the welding area. This area as you can see, is approximately 30 ft. by 40 ft. by 20 ft. (24,000 cu. ft.)

The next slide (Figure 3) illustrates the use of a smaller size portable atmospheric control system. This is used to establish environmental control around the "Dollar" weld in the S-IC bulkheads. Here also, a plastic-type curtain and an air-conditioning system are used to control the dust, moisture, and temperature.

The aims, as I have pointed out previously, are seen on the next slide.

Atmosphere Controlled Environments:

1. Dirt and Dust Level Control:

It is necessary to keep to a minimum the dirt, dust, or other foreign matter that may be in the atmosphere which could cause defects in welds.

2. Draft or Wind Control:

It is necessary that drafts, movement of air, etc. in the immediate area of the welding arc be controlled. Such things as open doors, people walking by, or fans have been found to cause serious problems in maintaining accurate, inert gas welding in welding arcs which have also been found to create serious problems in obtaining high quality welds.

3. Moisture Control:

High humidity in the southern climate, both here and at places such as Michoud or coastal areas either in California or Florida, normally have excessive humidity in the air. At times, it has been found that liquid moisture will evolve in the first welding pass made at the beginning of the day. This is caused by moisture which has been absorbed by the material in the cooler nights, and upon the application of welding heat, draws the moisture to the surface of the metal.

4. Temperature Control:

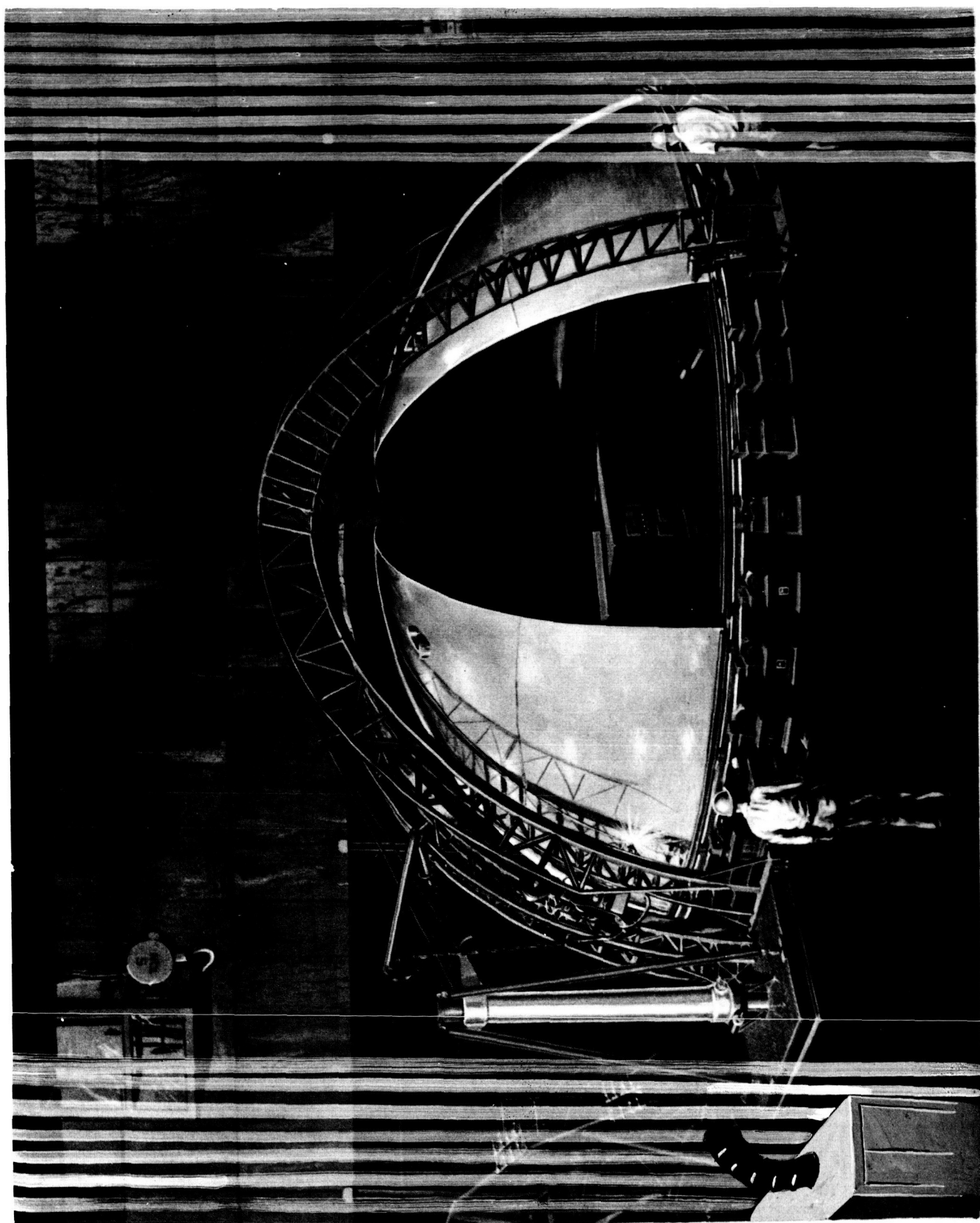
In controlling the conditions in the welding area, it is also important that the temperatures in the area of the welding arc be constant and uniform. This is so that from day to day, morning till night, the temperature will be uniform and the welding conditions reproducible, thus insuring high quality welds.

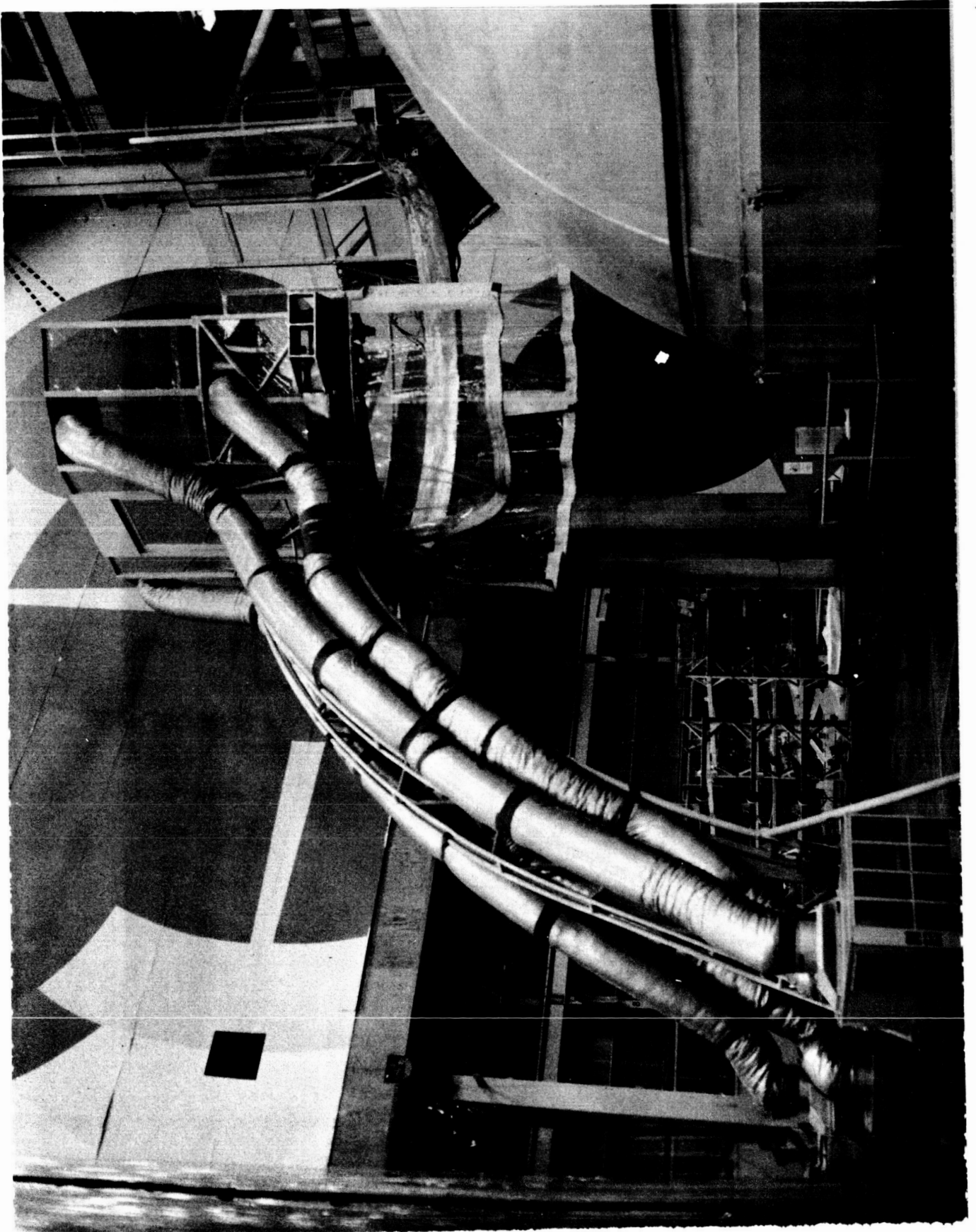
These controlled areas in the pilot-line production fabrication on the S-IC bulkheads are only a beginning. More information must be obtained as to the need for controls, the advantages of controls, and the limitations of atmosphere contamination in the area of welding operations.

The next slide is an artist's concept of an experimental area that is currently being installed in Marshall's experimental welding laboratory, Bldg. 4728. This area is designed to control the four major items at this time felt necessary to consistently produce high quality welds. They are dust, drafts, moisture, and temperatures. It must be pointed out that initially this controlled area will not have humidity control. This first experimental, environmental controlled area is to be used to develop the optimum conditions for welding one of the more difficult production welds, namely the Y-ring-to-bulkhead. This weld is made in the horizontal position using a square butt joint and the TIG process. To date, this has been found to be the most difficult as far as obtaining reproducible high quality welds needed in space vehicle structures. While it has not conclusively been decided that atmospheric conditions have been a major cause in the difficulties involved with this particular weld, it is felt that all precautions must be taken to insure future high-quality, reproducible welds in this particular weldment.

The exact needs for environmental control are not known. We hope that during our study with this control area to establish the things that need controlling and the degree to which they should be controlled to obtain the required quality for space vehicles. It is hoped that these studies in this controlled area will establish the limitation of the need for controlling the various factors that can affect welding quality. We may have gone too far in controlling, for example, temperatures. Maybe we could have wider limitations than we have established for this particular controlled area. This area now is designed for controlling the temperature to within ± 5 degrees. It may be that we could have 20 degrees either side of this current established level. The same is true for humidity, wind, for drafts, and dust level. It is hoped that the results of our studies will set the pace for space vehicle fabrication needs in the control of atmospheric conditions and still obtain the extreme high quality needed to obtain the reproducible maximum quality that will result in successful flight space vehicle systems.

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ATMOSPHERE CONTROLLED ENVIRONMENTS

- 1. DIRT AND DUST LEVEL CONTROL**
- 2. DRAFT OR WIND CONTROL**
- 3. MOISTURE CONTROL**
- 4. TEMPERATURE CONTROL**

ENVIRONMENTAL CONTROL AREA EXPERIMENTAL Y-RING TO BULKHEAD STATION

